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STRATEGIC CHALLENGES FOR THE EUROPEAN TELECOM SECTOR: THE CONSEQUENCES OF IMBALANCES IN INTERNET TRAFFIC

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The current business model of European telecommunications operators is unsustainable. According to Liebenau, Elaluf-Calderwood, and Karrberg, the old model does not reflect new architectures for the provision of digital services. It is economically unfeasible, they say, to continue to promote the idea of a "dumb pipe" industry alongside a services and content industry. However, network neutrality requirements could stand in the way of application-based charging, significantly hampering market development. To survive, operators need a new multi-sided strategy built around different modular types of traffic in order to link their business models to emerging Internet value chains.

INTRODUCTION

The European telecommunication sector has been challenged on its business structure and future viability by many factors that can be summarized in four major areas: first, a significant shift in revenue stream sources (driven by the expansion of the Internet, especially mobile applications); second, the increase in European Union and national service expectations (e.g. Digital Agenda for Europe 2020 and national broadband plans) which require significant investment that affects shareholder dividends; third, the major change in users and patterns of digital services and products; and fourth, the formation and evolution of interrelated digital platforms for services. These areas have each been addressed separately, with the consequence of a high level of fragmentation between business strategies and approaches from political economy.

This article presents an analysis of how the sector will deal with these challenges by assessing two areas: the strategic problems of the current business layout; and what the sector needs to define, provision, and achieve to continue being competitive. The drive to shift from legacy copper connections to high capacity optical fiber creates challenges for investment returns and pricing policies that are highly controversial. Many incumbent European companies are facing this sort of upgrade expense for the first time since the privatization and liberalization that was initiated in 1998. Up to that time infrastructure policy as well as investment was publicly led. This time there is an

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impetus for public policy initiatives to meet EU and national goals for widespread high bandwidth access, but the expectation is that the investment will be at least 90% privately funded.

This has led to extensive consultation and hand-wringing, given the general conditions for business and of new structural models, such as the rise of content delivery networks (CDN) that threaten the sustainability of the current telecom operators' business models. In response, incumbents have taken a variety of strategic approaches. Some have chosen to have a dynamic approach to these challenges and have started diversifying their products and digital services to align them with new digital platforms. Others have chosen to continue with their current business model, sometimes with an effort to diversify or in some cases to focus on the enterprise sector and leave the consumer sector to the CDN (content delivery network) providers.

In the European context, the diversity of ownership status at telecom providers (from wholly privately owned companies to semi-privatized firms) and the goals of service defined in the statutory formation of these companies (e.g. service to rural areas, quality of service requirements, universal service obligations, etc.) present a serious difficulty when coming to define policy based on the economics of this industry. These, in turn, have generated a variety of regulatory regimes that have differential effects upon different elements of the overall network. Some of these regimes have created regulatory options that preserve elements of self-regulation, some are intended to provide general guidelines for parts of the industry, and others are intended to correct for specific instances of market failure, as with certain price setting constraints. The risk associated with not providing a sustainable platform for the development of the future European telecommunications industry will not only mean in real terms the end of the current prevailing business model, but could seriously affect GDP growth and the labor market through job losses.[1] It will also affect the European technology innovation cycles to which telecom operators contribute significantly with their research and development budgets.

DIGITAL INFRASTRUCTURES AND TELECOMS

Given the Internet's role as the key enabler of applications and services, it is surprising that a substantial fraction of users, policymakers, network operators, and other actors apparently ignore the changes brought about by the increased digitalization of the physical telecom infrastructure value chain. The new services enabled by the Internet are changing the economics, and indeed the very nature of the physical as well as virtual features of the telecoms industry.

Europe's telecommunications infrastructure is regulated by national bodies that monitor its development; this is a legacy from the state-owned origins of the industry that has been shifted to other property regimes since 1998.[2] Although the legal ownership of a network might belong to a

[1] Nina Czernich, Oliver Falck, Tobias Kretschmer, and Ledger Woessmann, "Broadband Infrastructure and Economic Growth," *The Economic Journal* 121, No. 552 (2011): 505-532.
[2] United Kingdom, Department of Trade & Industry, "Communications Liberalisation in the UK: Key Elements, History and Benefits," white paper, March 2001, 28.

foreign partner, some services and the physical provision of the network must satisfy requirements for national consumers. This is not the case for the emerging telecoms digital infrastructures and their use of the Internet. Telecom operators have the local advantage of direct access to customers' physical location, and this role makes them prominent as the customers' point of contact, even if they are far removed from the actual provision of content.

The phenomenon of the convergence of physical telecom networks and the provision of digital services creates complications – e.g. choice of supplier and pricing – for the consumer as well as for the telecom operator.[3] A consumer gets services provided from somewhere and can also, via (for example) mobile application stores, deliver content or the services themselves to anywhere.[4] Telecom operators have been slow in understanding that the old telecom model for billing does not reflect the new architectures for the provision of digital services and have relied for too long on their profit model and in billing for use based on distance, entry access point, and time. In part this is because the current pricing structure does not take into account the changes in traffic origin, type, and demand. Overall there is a sense of a loss of control by telecom incumbents of the core areas of revenue,[5] as evidenced by the fact that most European network operators do not have a complete picture of the sources and nature of the traffic that they carry.

The more players that emerge who take advantage of the new digital services, the more difficult it is for traditional telecom operators to cope with the consequent disruptive effects. In addition to the content delivery networks (CDNs) there are many Internet content and service providers (commonly called "over the top players" or OTTs), cable providers who offer services far beyond subscription television such as the multi-channel video programming distributors (MVPDs), virtual multi-services operators (virtual MSOs), and others who make it difficult for telecom operators to understand the ways their core assets are being used.

More importantly, content provision has created new types of topologies on the Internet, as illustrated in Figures 1 and 2 below. This representation of the Internet is based on methods that are highly quantitative. Some of those analytical approaches give interesting insights into the migration and evolution of the topologies,[6] but value propositions are still not analyzed in detail. As pointed out by several telecommunications specialists, further insight is required on how to address the issues of pricing[7] and the evolution of digital services.[8]

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[3] Oliver Spatscheck and Jacobus Van der Merwe, "The Unpublicized Sea Change in the Internet," *Internet Computing* 15, no. 1 (2011): 92-95; Jan D. Herzhoff, "Unfolding the Convergence Paradox: The Case of Mobile Voice-Over-IP in the UK," white paper, The Information Systems and Innovation Group, London School of Economics and Political Science (2011).

[4] V. Brian Viard and Nicholas Economides, "The Effect of Content on Global Internet Adoption and the Global 'Digital Divide'," working paper, NET Institute (2011).

[5] Jonathan Liebenau, Patrik Karrberg, and Silvia Elaluf-Calderwood, "A Critical Analysis of the Effects of Traffic on Business Models of Telecom Operators," white paper, LSE and ETNO Research Collaboration Programme (2011), 16.

[6] Hanne Kristine Hallingby and Olai Bendik Erdal, "The Norwegian Internet Economy: A Case Study," R&I Research Note, Telnor (Oslo, Norway), Dec. 20, 2011, 52.

[7] Vytautas Valancius, Cristian Lumezanu, Nick Feamster, Ramesh Johan, and Vijay V. Vazirani, "How Many Tiers? Pricing in the Internet Transit Market," *Proceedings of the ACM SIGCOMM 2011 Conference* (2011): 194-205.

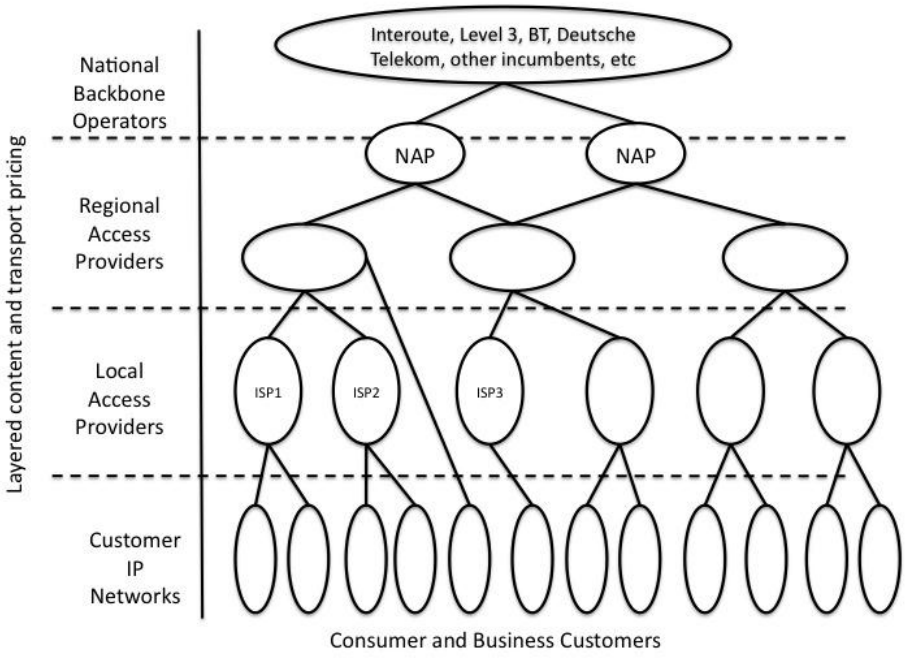

Figure 1: Traditional Internet Logical Topology [9]

The key commercial problem is that demand forecasts do not address the many uncertainties attached to the development of the Internet,[10] especially the emergence of the mobile Internet.[11] The relationships among national versus regional and global providers are even more relevant for telecom operators than before. Most telecom operators are restricted by national and regional regulatory frameworks to provide a few specified products and services to consumers for which they are regulated with respect to pricing, type, and mode of access.[12] The new players are mainly global and are taking significant advantage of new, unregulated technologies and business models to provide, in many cases, faster alternative propositions to telecom service platforms and take the dominant or monopolistic role in the provision of digital services, as described by Noam in his studies on concentration in the media industry.[13] Given that regulation exists for access points and

[8] Berin Szoka and Adam Marcus, ed. *The Next Digital Decade: Essays on the Future of the Internet* (Washington: TechFreedom, 2011).
[9] Adopted from Craig Labovitz, Scott Iekel-Johnson, Danny McPherson, Jon Oberheide, and Farnam Jahanian, "Internet Inter-Domain Traffic," *Proceedings of the ACM SIGCOMM 2010 Conference* (2010): 75-86. This is the most common understanding of Internet logical topology, which is at the core of the telecom operators' billing structure for services and infrastructure. This model of the architecture stresses the layered delivery of products and services.
[10] Cisco Systems, "Entering the Zettabyte Era," white paper (2011), 16.
[11] Cisco Systems, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011-2016," white paper (2012), 29.
[12] Chuan Fu, Guoqing Zhang, Jinh Yang, and Xioana Lu, "Study of the Contract Characteristics of Internet Architecture," *Enterprise Information Systems* 5, no. 4 (2011): 495-513; Dan Breznitz, Martin Kenney, Petri Rouvinen, John Zysman, and Pekka Yla-Anttila, "Value Capture and Policy Design in a Digital Economy," *Journal of Industry, Competition and Trade* 11, no. 3 (2011): 203-207.
[13] Eli M. Noam, *Media Ownership and Concentration in America* (Oxford, UK: Oxford University Press, 2009).

for many aspects of the physical infrastructure, the real effects of convergence along with the blurring of boundaries between services and digital infrastructures has called into question the old distinctions between what regulators should and should not regard as within their purview.

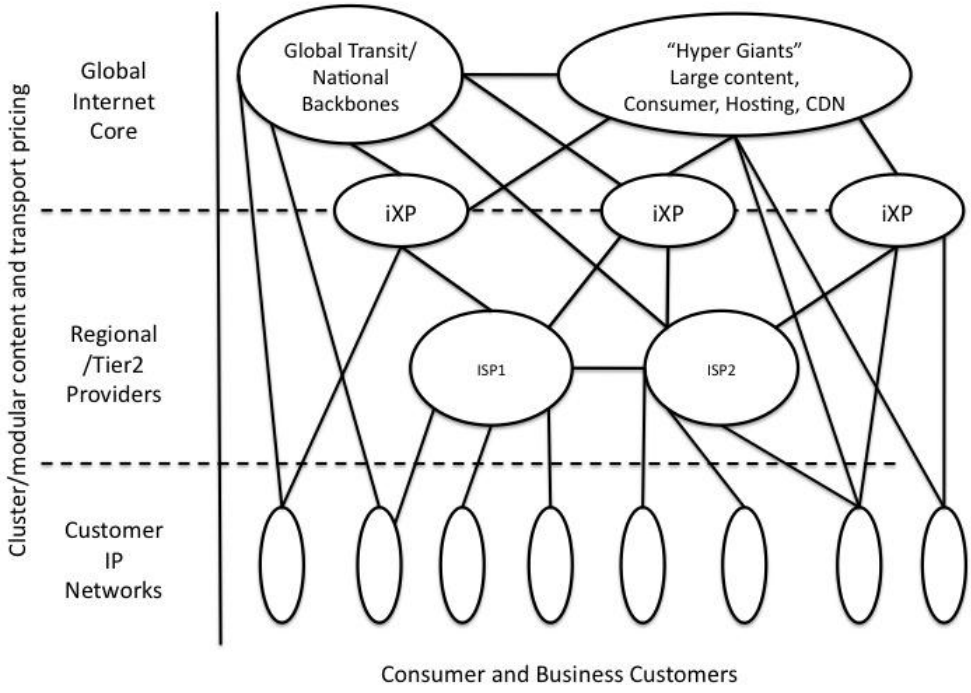

Figure 2: The Emerging Internet Logical Topology [14]

Additionally in Europe, the requirement to build out new infrastructure is currently undermined by the refusal of private telecom operators to foot the whole of the bill for such upgrades. This threatens their ability to cope with the demand for digital services as well as to keep a competitive edge in the region. This could undermine both the goals of the Digital Agenda for Europe 2020[15] and the assumption that improvements will come from continuous innovation.

If the modularity of services is taken as the new dominant trend shifting the Internet infrastructure, then the issues of the provision of digital infrastructures are expressed in three areas: traffic, business

[14] Adopted from Labovitz, et al. This diagram is a high-order description of the evolution of Internet distribution based on the logical (but also physical) dominance of new players in the telecom system. This model stresses the modular delivery of products and services as described in detail in Christopher S. Yoo, "Innovations in the Internet's Architecture that Challenge the Status Quo," *Journal of Telecommunications and High Technology Law* 8 (2010): 79-92. See also Christopher S. Yoo, "Layering, Modularity Theory and Innovation," forthcoming, 2012, listed at https://www.law.upenn.edu/institutes/ctic/research.php.

[15] European Commission, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (Digital Agenda for Europe 2020)," Aug. 26, 2010, accessed Nov. 9, 2012, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52010DC0245R%2801%29:EN:NOT.

models, and regulation. For each of these the literature provides a number of models. These areas have different assumptions about the relationships among telecommunications stakeholders. Furthermore, relationships between control and innovation follow dynamic and sometimes paradoxical paths among those agents.

From our original assumption that the European telecommunications sector needs to accommodate the Internet's strategic challenges, we can build a matrix of challenges and choices related to the issues described above. Table 1 below shows this simplified matrix.

Table 1: Digital Infrastructure Challenges for Telecommunications Companies

	Traffic issues	**Business models**	**Regulatory challenges**
Strategies	Accounting for the role of new players (e.g. the OTTs)	Stratification of pricing structure	Two paths: protectionist approach to regulation or economic liberalism
Requirements	Understanding traffic patterns, capacity, and modularity	Composition of new digital services and control of digital platforms	Determine how regulation can keep the innovation flowing and avoid choking service value chains

In the next sections we will explain how these problems can be analyzed for the particular European context.

TRAFFIC

The common approach of the telecommunications industry to Internet traffic has been for unlimited provision of networks and upgrades as capacity requirements increased. This was true in the 1997-2009 period in most of Europe, Japan, and the United States,[16] and the growing expansion rate currently being sustained in Asia, Latin America, and Africa replicates such effects. The character of technological change in fiber, switches, routers, and other physical components providing the interface between the physical network and the IP networks (or other technologies such as ATM) allowed for this assumption.[17] However, even with ambitious extension plans there are increasing reports of congestion from operators who have seen congestion signals arising at the

[16] Patrik Karrberg, *The Emergence of the Mobile Internet in Japan and the UK: Platforms, Exchange Models and Innovation 1999-2011*, doctoral thesis, London School of Economics (2011), 256.
[17] Zofia Lukszo and Gerard P. J. Dijkema, "The Operation and Evolution of Infrastructures: The Role of Agent-Based Modeling and Decision Making," *International Journal Critical Infrastructures* 5, no. 4 (2009): 299-307.

network level for the TCP stack.[18] These traffic trends are important to understand so that technical and business propositions can be made for operators, content providers, regulators, and users.

The pricing estimate to consumers was based on their willingness and desire to buy and consume new services through their network providers.[19] The principles of such exchange were made on the assumption of a two-sided market structure[20] and the principles of network neutrality as defined by the Federal Communications Commission in the United States.[21] As a legacy from a layered network architecture, ISPs relied on two basic types of contracts for exchanging traffic (peering and transit), while ISP interconnections were not price regulated.[22] This is no longer the case in terms of architecture, traffic demands, and pricing structure.

The layered model of the Internet is a legacy of the early implementation of telecommunications networks (see Figure 1 above), which is now shifting to some degree to a modular model (see Figure 2 above). Early views of those changes indicated that it would be necessary to shift the way the layered architecture is analyzed.[23] Traffic data provided by major manufacturers of Internet devices such as Cisco[24] or Alcatel Lucent[25] and backbone network providers such as Akamai[26] have attempted to explain this evolution and to project traffic trends by shifting from specializing by type of physical provision (e.g. fiber, copper broadband, mobile IP, etc.) to more representative and modular descriptions of traffic trends (e.g. mobile TV, social network traffic, etc.). The preliminary indicators are that there has been a change from older conceptions of telecom business models and pricing affecting most telecom players.

To embed these changes in capacity, what is required is to look for a new approach to infrastructure modeling[27] that can not only analyze the traffic shifts influencing different regions and countries but also identify the commonalities and areas where resilience will be required. The layered model with

[18] Steven Bauer, David Clark, and William Lehr, "The Evolution of Internet Congestion," paper presented at the Telecommunications Policy Research Conference, Arlington, VA (2009).
[19] Nicholas Economides. "Broadband Openness Rules Are Fully Justified by Economic Research," *Communications and Strategies* 84, no. 4 (2011): 1-25.
[20] Nicholas Economides and Joacim Tag, "Network Neutrality on the Internet: A Two-Sided Market Analysis," *Information Economics and Policy* 24, no. 2 (2012): 91-104.
[21] Federal Communications Commission, "In the Matter of Preserving the Open Internet," GN Docket No. 09-091, Dec. 23, 2010; David S. Evans, "Net Neutrality Regulation and the Evolution of the Internet Economy," *Antitrust Chronicle* 2011, no. 8 (2011).
[22] David Clark, William Lehr, and Steven Bauer, "Interconnection in the Internet: The Policy Challenge," paper presented at the Telecommunications Policy Research Conference, Arlington, VA (2011).
[23] Yihua He, Georgos Siganos, Michalis Faloutsis, and Srikanth Krishnamurthy, "Lord of the Links: A Framework for Discovering Missing Links in the Internet Topology," *IEEE/ACM Transactions on Networking* 17, no. 2 (2009): 391-404.
[24] Cisco Systems "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011-2016."
[25] Bill Krogfoss. "Analysis: Content Peering and the Internet Economy," Alcatel-Lucent, Apr. 19, 2011, accessed Oct. 31, 2012, http://www2.alcatel-lucent.com/blogs/techzine/2011/analysis-content-peering-and-the-internet-economy/?s_cid=smm_tmc0023_bl.
[26] David Belson, "The State of the Internet: 1st Quarter 2011," report, Akamai Technologies Inc., Vol. 4, No. 1 (2011), 40.
[27] Chris Davis, Igor Nikolic, and Gerard P.J. Dijkema, "Infrastructure Modelling 2.0," *International Journal of Critical Infrastructures* 6, no. 2 (201): 168-186.

its interconnection agreements does not just route traffic in the Internet, but also routes money.[28] The aims of a revenue-neutral peering model between CDNs and access ISPs might require revision at the core of the architecture and changes as to how traffic is priced at that core.

Perhaps the most important area where this infrastructure modeling requires revision is in the form of modularity. From the point of view of service logic, a number of choices can be made to accommodate an architecture of modularity for service conveying in a way to better meet the requirements and specifications of traffic demands. Early proposals for architecture modularity were intended to understand the industry, the service actors and the supply chain, to structure services bundled for delivery and the service package and component.[29] For most European telecom operators there is insufficient clarity about how, for example, mobile Internet TV[30] providers distribute content over the current networks. Operators have not accounted for the many beneficiaries of the supply chain (e.g. advertisers; content providers such as music publishers, aggregators; etc.). Too little is taken into account of how those services are bundled for digital delivery (e.g. the case of MVPD[31]), and how the billing attached to those packages can result in underpriced services.

The current architecture of the Internet is one that is largely open but populated with many proprietary standards (e.g. Microsoft APIs and Apple standards), having moved from a more open system using public standards.[32] We can now describe the Internet as being highly mixed with many closed and proprietary standards at the service level to compete and in some cases dominate service provision.[33] This modularity has not been replicated in the physical provision of the telecommunications infrastructure,[34] which has been slow to adapt or even modify its original layout.[35] Current proposals for how to address the shift in traffic origin and destination fail to

[28] Clark, Lehr, and Bauer.
[29] Christopher A. Voss and Juliana Hsuan, "Service Architecture and Modularity," *Decision Sciences* 40, no. 3 (2009): 541-569.
[30] Kaiser Wahab, "Is YouTube Too Big to Fail?" Mashable, Feb. 21, 2012, accessed Oct. 31, 2012, http://mashable.com/2012/02/21/youtube-too-big-to-fail/.
[31] See for example Federal Communications Commission, "Media Bureau Seeks Comment on Interpretation of the Terms 'Multichannel Video Programming Distributor' and 'Channel' as Raised in Pending Program Access Complaint Proceeding," Mar. 30, 2012, accessed Oct. 31, 2012, http://hraunfoss.fcc.gov/edocs_public/index.do?document=313339.
[32] Carliss Y. Baldwin and C. Jason Woodard, "Competition in Modular Clusters," working paper, Harvard Business School (2007).
[33] Raghu Garud, Arun Kumaraswamy, and Richard M. Langlois, ed. *Managing in the Modular Age: Architecture, Networks and Organizations* (Malden, MA: Blackwell, 2003). The case of SMS revenues and telecom operators is very interesting. Year by year these revenues are being reduced due to users' shift to data messaging services such as Facebook messaging, which is embedded in the Facebook pages for mobile users and hence not counted as billable traffic following the traditional telecom model.
[34] Currently the International Telecommunications Union is revising the terms of the telecommunications treaty. International Telecommunications Union, "General Conclusions and Executive Summary of the Final Report," report, Apr. 23, 2012.
[35] Brett M. Frischmann, *Infrastructure: The Social Value of Shared Resources* (Oxford, UK: Oxford University Press, 2012).

recognize that such modularity is now an essential part of the core process the network architectures require.[36]

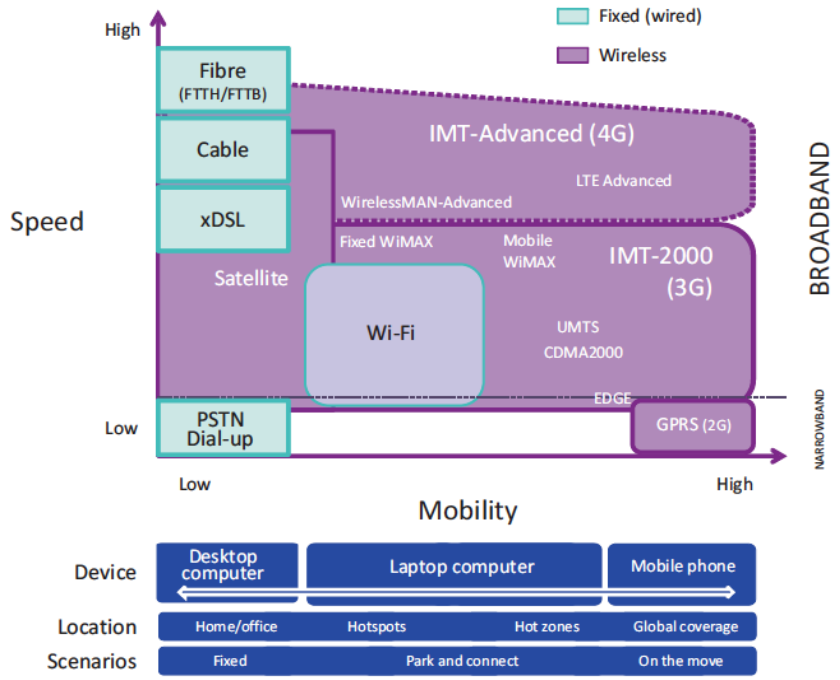

Figure 3: Increase of Mobile Use of the Internet, Based on Location and Type of Connection [37]

Hence, any future analysis of traffic requires an understanding of where the shifts are by module and who is excising control in the provision of the content or data that is being distributed at any particular time. The provision of this content is lead by certain assumptions of a low level of control of the flow of content that allows a high level of generativity as described by some Internet scholars.[38] However, this is not enough to support the economic requirements for network deployment, maintenance, and enhancement. Control is necessary not only from a strictly technical point of view but it must also consider the socio-technical forces driving the shifts in the use of the Internet; some of the control will be relinquished in order to establish a delicate balance between innovation or generativity and content distribution.[39] Figure 3 above is a forecast from the International Telecommunications Union showing that they believe the consumption of data is

[36] ATKearney. "Internet Value Chain Economics," white paper (2010), 32; Brian Williamson, David Black, and Thomas Punton, "The Open Internet: A Platform for Growth," white paper, Plum Consulting, October 2011, 49.
[37] Ibid.
[38] Jonathan L. Zittrain, "The Generative Internet," *Harvard Law Review* 119, no. 7 (2006): 1974-2040; Jonathan L. Zittrain, *The Future of the Internet – And How to Stop It* (Harrisonburg, VA: R.R. Donnelly, 2008).
[39] David Tilson, Carsten Sørensen, and Kalle Lyytinen, "Change and Control Paradoxes in Mobile Infrastructure Innovation," paper presented at the Hawaii International Conference on System Sciences (2012).

increasingly likely to be distributed over multiple types of forms.[40] From their perspective, too, what matters is the content and not the "pipe." Multiple devices, forms of transmission, technologies, etc. are merely the way for the "pipe" to distribute content. To continue with a model in which the access point is the core of the billing system does not reflect well in the changes happening to the Internet and traffic demand.

In addition to depicting the significance of the mobile Internet, Figure 3 also illustrates Cisco's expectations about the increase in IP traffic, as presented in Table 2 below. Much of the growth is expected to be in television and associated with new social applications. However, these large-scale shifts in usage force us to reevaluate how demand will be satisfied. As everyday life becomes increasingly dependent upon critical infrastructure systems (e.g. e-health, security monitoring systems, etc.) as well as social networking, both the costs and value of the network change.[41]

Table 2: Global Consumer-Managed IP Traffic, 2010-2015 [42]

IP Traffic 2010-2015							
By type (PB per month)	2010	2011	2012	2013	2014	2015	CAGR 2010-2015
By network (PB per month)							
Fixed	3692	5623	7016	9090	10499	11832	26%
By sub-segment (PB per month)							
IPTV VoD	612	878	1177	4197	1770	2041	27%
Cable Digital VoD	3042	4310	5791	7321	8309	9212	25%
Cable Hybrid IP VoD	38	75	148	271	420	579	72%
By content type (PB per month)							
Standard Definition VoD	1968	2274	2359	2379	2556	2854	6%
High Definition VoD	1721	2967	4753	6700	7923	9140	40%
3D VoD	1	2	5	11	20	38	137%

[40] International Telecommunications Union, *Measuring the Information Society*, 174.
[41] Koen H. Van Dam and Zofia Lukszo, "Model Factory for Socio-Technical Infrastructure Systems," *Intelligent Infrastructures* 42, Pt. 1 (2010): 25-52.
[42] Cisco Systems, "Entering the Zettabyte Era," 16.

By geography (PB per month)							
North America	2421	3402	4556	5665	6322	6878	23%
Western Europe	599	866	1225	1653	1954	2244	30%
Asia Pacific	281	405	539	734	938	1143	32%
Japan	320	428	540	650	719	783	20%
Latin America	18	35	64	110	175	267	71%
Central and Eastern Europe	41	92	160	249	354	470	63%
Middle East and Africa	11	17	23	30	37	47	33%
Total (PB per month)							
Managed IP video traffic	3692	5623	7116	9090	10499	11832	26%

Although the study of demand by type of traffic is very clear in the shift in consumers' usage of data, further analysis of Europe can be made by examining the evolution of national autonomous system (AS) ownership as assigned to domains with specific country extensions and its correlation to the types of traffic transport and content providers. AS numbers[43] are registered by regional and local authorities and companies providing services in a region, and they normally have an AS presence registered in the Regional Internet Registry (RIR).[44] Early studies of the European Internet indicate that due to the globalization and compacting of services – through clouds or CDNs or proprietary networks – local or regional companies in Europe are using AS numbers not registered regionally. For example, an in-depth analysis of the Norwegian Internet market shows the extent to which that is the case.[45]

Table 3 below illustrates an overview of the Internet described within the parameters of the Norwegian physical jurisdiction, based on a study completed in 2011 by one of the incumbent network operators. The link between the AS numbers and the type of enterprise that can be identified as national or local is clear. The study went further to differentiate the various types of AS clustering adopted by the companies to deliver their services. According to this research, the number of companies providing IT services through non-registered AS numbers within Norway is on the increase. We believe that when we compare this situation with what is happening in European local Internet registries to investigate patterns or changes on the Internet layout we will see a distinct European form of Internet modularity.

[43] "An AS is a connected group of one or more IP prefixes run by one or more network operators which has a *single* and *clearly defined* routing policy." As defined in 1996 at IETF Network Working Group, "Guidelines for Creation, Selection, and Registration of an Autonomous System (AS)," accessed Oct. 31, 2012, http://tools.ietf.org/html/rfc1930.
[44] The regional internet registries or RIRs are: AfriNIC (Africa), ARIN, APNIC, LACNIC, and RIPE NCC.
[45] Hallingby and Erdal, 52.

Table 3: AS and Domains Distribution in Norway [46]

	Data category	Comparison	Description
Data collected for the Internet in Norway	Autonomous system (AS) numbers	282 AS numbers with services in Norway (166 Norwegian and 116 international)	157 enterprises hold 166 Norwegian ASs 115 of the Norwegian ASs not listed by Norwegian authorities 231 of total AS numbers not listed by Norwegian authorities
	E-commerce actors	159 actors listed as broadband providers by Norwegian authorities	51 have AS number 108 have no AS number, hence are virtual ISPs
	Domains	528,000 (.no) domains 248,000 .com/.net/.org/.info/.biz domains	New insight into the total number of domains in Norway New insight in location of domains (network and nation)
	Structural ASs distribution	**Classification of AS**	**Type of ASs**
Classifications and findings	Categorizing	ASs categorized into 15 different types	Diversified 1/3 traditional Internet access providers 2/3 other types
	Clustering	Data sets were matched with particular AS numbers based on resources indicators	Clusters emerge between AS numbers, holding different volumes of resources
	Archetype		Suggest four mutually exclusive archetypes of Internet actors

This, we believe, will confirm the character of the shift of the layered model to a modular Internet. This shift coincides with the move away from control of routing from low-level routing protocols to

[46] Ibid.

higher-level agreements among stakeholders. We believe that this pattern of limited jurisdictional control within European countries is a major feature of change that distinguishes the European Internet from that in the United States and other nations. These features[47] are not taken into account sufficiently either in international bodies governing the Internet (e.g. ISOC, IETF, etc.) and the international telecommunications system, or by the European Commission and Member States' regulatory agencies.[48]

Despite its unique character by virtue of small size, wealth, and industry structure, Norway's Internet situation is similar to that in many European countries in other ways as well. The instability of the network provision stems from the inability of network operators to adapt and link the emerging value chains to their business model. Even the prospect of such change undermines the way European providers have done business, in contrast to their US counterparts. The European telecommunication sector does not have powerful brands in CDNs or cloud computing. Furthermore, none of the European incumbents have been able to match the negotiation terms AT&T and Apple deployed leading up to the introduction of the iPhone in 2007.[49]

Some might blame this situation on the lax role of regional or national regulators, but we need to be able to assess it more subtly because on first impression this is not a severely distorted or dysfunctional market. Rather, the power relations that describe the balance between users and network providers look very different in Europe from those in the US. At worst this undermines the business models of European incumbents who are unable to assure investors that revenues will remain at a level such that they are able to provide the maintenance the telecommunications network requires. We are convinced that the key to studying this consolidation of the Internet is by looking at traffic patterns and AS consolidation, because this provides unique insight into the types of digital services offered by other stakeholders that are in direct competition with the revenue models used by European telecom operators.

BUSINESS MODELS

The new architecture and the projected levels of traffic make it increasingly difficult to maintain the current neutral peering and traffic balance requirements matched to the pricing of the Internet architecture.[50] The core of the challenge is to preserve the competitiveness of interconnection markets. If we wish to see a market-based pricing system without major information asymmetries then it would be advantageous to understand the relationship between traffic and pricing.

[47] These features can be understood as part of the metrics taken into account to describe how traffic is measured and accounted within physical jurisdiction areas.
[48] Yoo, "Layering, Modularity Theory and Innovation."
[49] Nilay Patel, "Confirmed: Apple and AT&T Signed Five-Year iPhone Exclusivity Deal – But Is It Still Valid?" Engadget, May 10, 2010, accessed Oct. 31, 2012, http://www.engadget.com/2010/05/10/confirmed-apple-and-atandt-signed-five-year-iphone-exclusivity-de/.
[50] Robin S. Lee and Tim Wu, "Subsidizing Creativity Through Network Design: Zero-Pricing and Net Neutrality," *Journal of Economic Perspectives* 23, no. 3 (2009): 61-76.

Additionally, it is necessary to encourage transparency in commercial agreements through the enhanced use of better information about traffic patterns[51] and on the incremental costs of supported usage. Such actions will require updating the current terms, conditions and norms to the emerging ones from these new consumption patterns.[52]

For many telecom operators there are five major kinds of challengers to their current business models:

1. *Content aggregators*: Those entities that own the rights for the content that is distributed over the Internet. This content may be either user-generated or produced by commercial organizations.

2. *Online services providers*: Those entities that provide services that are accessed by users of the Internet. These are diverse for both consumer and corporate markets, including content aggregators, search engines, and community providers. In Europe, British Telecom has set the pace in diversifying its offerings, although it has initiated numerous restructuring processes to work out effective business models.

3. *Equipment and enabling technology providers*: Those entities that facilitate the technical delivery of web content and the generation of revenues. These typically fall under the banners of support technology, billing and payments, and advertising services.

4. *Distribution and connectivity providers*: Internet service providers or those entities that enable access to the Internet. These consist of organizations that provide core network connectivity, those that provide IP interchange, and those that sell retail Internet access to end users. Most incumbents fall in this category.

5. *User interface and devices*: Those entities that facilitate hardware, operating systems, and software that enable end users to interact with the Internet (e.g. Google with Android, Apple, and other new players).

The relationship between growth in consumption and the pricing structure of digital Internet services remains a problem.[53] Policymakers assume investment is required to expand the capacity of networks supplying digital services, hence some of the pricing used for the forecast calculations will have variations on the impact on network investment; probably on the upper side if trying to cover the real costs of implementing new infrastructure, perhaps on the lower side if upgrades are subsidized by governments or left to competition to decide what is best. Additionally the estimation of externalities of Internet services has been oversimplified,[54] and thus it loses the edge in

[51] Clark, Lehr, and Bauer.
[52] ATKearney, "Internet Value Chain Economics."
[53] Boston Consulting Group, "The New Rules of Openness," white paper (2011), 56.
[54] Lin Zhongyan, "Analysis of Externality Based on Internet," paper presented at the International Conference on Multimedia Information Networking and Security (MINES), Nanjing, China (2010).

understanding the value propositions from many Internet companies or platform content providers within the system.

This is evidently the case for the European telecommunications sector, where many industry reports indicate a serious undervaluation of estimates required to cover network enhancement and current service maintenance.[55] To address the gap, a number of value propositions are being discussed by the incumbents based on consultants' reports[56] supporting a shift in the charge for traffic which will in effect mean the end of Internet neutrality as defined in terms of "quality of service" instead of "best effort" for certain modular services (e.g. video on demand).[57]

However, it is important for mobile operators and traditional telecom operators to generate additional revenues with usage. Net neutrality conditions prohibiting tiered service levels and pricing, or two-sided pricing with contributions from Internet content and services providers to operators, could significantly hamper market developments. In the future European regulators may adopt more laissez-faire approaches that will stimulate investments in high-quality networks for service delivery, including video. These actions might be contradictory to some of the early embracers of a strong legal interpretation of network neutrality such as the Netherlands.[58]

So far the responses of the telecom industry have followed a number of strategies, which are a mix of what operators and their suppliers are trying to do to answer these challenges. These strategies are grouped as follows:

1. *Personalize*: Charging customers extra to use such services, with data plans tiered by application type (which is just another way to apply modular analysis to traffic).

2. *Prioritize*: Throttling – or even blocking – applications at the network level. This strategy has mixed results as it has a negative effect on the brand perception for the telecom operator pursuing this type of control against the provider of content, which is perceived by the consumer as "the good guy" providing a service for free.

3. *Monetize*: Attempt to extract money from "upstream" players by negotiating peak or burst rules in traffic for certain intervals of time.[59]

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[55] Stephen Howard, Adam Rumley, and Amit Sachdeva, "European Telecoms: Can You Price It?" white paper, HSBC Global Research, Apr. 21, 2011, 56.
[56] See for example Williamson, Black, and Punton.
[57] Alan Breznick, "The Way of IP Video," white paper, *Heavy Reading* series, Cisco Systems (2011), 8; International Telecommunications Union, "Revision of the International Telecommunications Regulations: Proposals for High Level Principles to be Introduced in the ITRs" (Contribution 109), June 20, 2012, accessed Oct. 31, 2012, http://www.itu.int/md/T09-CWG.WCIT12-C-0109/en, 2.
[58] Florian Schuett, "Network Neutrality; A Survey of the Economic Literature," *Review of Network Economics* 9, no. 2 (2010): Article 1; see also "Netherlands Makes Net Neutrality a Law," *BBC News*, June 23, 2011, accessed Oct. 31, 2012, http://www.bbc.co.uk/news/technology-13886440.
[59] Gabriel Brown. "Monetization Strategies for Mobile Operators," white paper, *Heavy Reading* series, Cisco Systems (2010).

4. *Compete*: Utilize inter-telecommunications operator collaboration on new standards such as Rich Communications (RCS/RCSe).[60]

All of these options face challenges. Net neutrality laws or regulatory frameworks and various technology limitations stand in the way of application-based charging. Internet companies show little inclination to pay for "quality," especially on networks with poor coverage.[61] Furthermore, many of the analyses done on Rich Communications show that their success is not likely.[62]

Another trend from telecommunication operators is to try to re-invent one sector of their business as telco-OTT ("over-the-top") players at once. They do so by packaging services via generic Internet access. From a preliminary count, we have identified around 80 operator initiatives of this type, spanning four main service categories: content, communications, cloud, and connectivity.

The major threat to current business models is the fast shift of revenue due to traffic created by OTTs.[63] The telco-OTT option seems to enable operators to take a more active role in creating products and services that can enhance their own revenue streams. Some possible ideas currently discussed as sustainable frameworks to achieve these goals are grouped into three areas: to expand their user-base reach to include countries in which they have no network footprint; to improve existing subscribers' experience when they are "off-net," for example helping them access their TV or voice services from PCs or mobile devices connected via other networks; and finally to benefit from both new revenue streams and the higher equity valuations placed on Internet businesses.

A telco-OTT has its own opportunities and challenges. Few services are easy to monetize, and experimentation (and sometimes failure) will be needed. However, customers want open-Internet services – they like the choice and flexibility, and this trend is apparently unstoppable. If telecom providers are to survive in the long-term, they need to embrace the broad range of Internet businesses or else replicate their services and compete directly. Furthermore it is necessary that the whole analysis of the telecom value chain moves from the economic analysis of two-sided markets

[60] For more information see GSMA, "Rich Communications," accessed Oct. 31, 2012, http://www.gsma.com/rcs.
[61] "How Should Fixed & Mobile Operators Deal with the So-Called 'OTT' Threat?" Disruptive Analysis, accessed Oct. 31, 2012, http://disruptive-analysis.com/index.htm.
[62] For further analysis, see ATKearney, "Winning the OTT War: Strategies for Sustainable Growth," Sept. 2012, accessed Nov. 9, 2012, http://www.atkearney.com/communications-media-technology/ideas-insights/article/-/asset_publisher/LCcgOeS4t85g/content/winning-the-ott-war-strategies-for-sustainable-growth/10192.
[63] For analysts, Facebook's increasing dominance of the social networking market has damaged mobile operators' sales from services such as text messaging, according to a study from M&A consultancy Magister Advisors. Facebook's over-the-top business model creates significant strategic and revenue risks for mobile operators, claims the firm, and is turning mobile operators into "digital drug mules" supporting a burgeoning global habit with little financial benefit. As the company went public and received enormous pressure from investors to turn profits, it is expected that Facebook's strategy will damage operators further, according to Magister. "Facebook's IPO is about the worst thing that could happen to network operators," said Victor Basta, managing director of Magister Advisors. "They're supporting the end users' social networking habits, but they see very little, if any, commercial benefit and the downside risks are significant." "Facebook IPO Is About the Worst Thing That Could Happen to Network Operators," Fierce Mobile Content, Apr. 4, 2012, accessed Oct. 31, 2012, http://www.fiercemobilecontent.com/press-releases/facebook-ipo-about-worst-thing-could-happen-network-operators.

to multi-sided markets with multiple actors performing various functions at different times with differing levels of control.[64]

European telecom operators have been slow in trying to address the challenges thrown up by the formation of platforms such as Apple and Android, and in the future perhaps static social networking sites such as Facebook and location-based ones such as Google Latitude and Baidu. Yet it is mobile usage that gives the real meaning to value chain models.[65] Platforms are not a new phenomenon – there has been much work on the business models at the service layer and studies about how this demand has affected the physical and logical architecture of the industry.[66] However, same platforms such as those deployed by Apple and Google are providing a convergence on services, despite architecture that is lagging.[67] Areas of investment aimed to generate competition and innovation[68] have put the telecom operators in many cases at a disadvantage, since they have not come up with successful options for consumers that can be widely embraced as alternatives to Apple iOS and Google Android.[69]

What is required in business models is to start, through detailed analysis of the traffic demands and architecture, to try to make sense of the agents involved in the provision and demand of services and how the control and innovation can be nurtured and sustained within the digital infrastructure. It is then for responsible business leaders to implement the resultant new strategies.

REGULATORY FRAMEWORKS

The challenge regulators continue to face is brought about by the contradictions between the view that liberalization and privatization should lead to perfect competition and the perception that telecom operators are critical elements of infrastructure and critical service providers. Overall the situation in relation to innovation creates a challenging environment as perceived by the Body of European Regulators of Electronic Communications. Figure 4 below is one view of the current status of the European telecom sector in relation to the rest of the world.

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[64] Kevin J. Boudreau and Andre Hagiu, "Platform Rules: Multi-Sided Platforms as Regulators," in *Platforms, Markets and Innovation*, ed. Annabelle Gawer (Cheltenham, UK: Edward Elgar, 2009), 163-191; Benjamin D. Eaton, Silvia Elaluf-Calderwood, and Carsten Sørensen, "A Methodology for Analysing Business Model Dynamics for Mobile Services Using Control Points and Triggers," proceedings of the 2nd Business Models for Mobile Platforms Workshop (BMMP), Berlin, Germany (2010).

[65] Jean-Louis Gassée, "Carriers Whine: We Wuz Robbed!" Monday Note, Mar. 11, 2012, accessed Oct. 31, 2012, http://www.mondaynote.com/2012/03/11/carriers-whine-we-wuz-robbed/.

[66] Catherine E.A. Mulligan, *The Communications Industry in the Era of Convergence* (London: Routledge, 2011), 171-209.

[67] Carliss Y. Baldwin and C. Jason Woodard, "The Architecture of Platforms: A Unified View," working paper, Harvard Business School (2008).

[68] Annabelle Gawer, "Platform Dynamics and Strategies: From Products to Service," in *Platforms, Markets and Innovation*, ed. Annabelle Gawer (Cheltenham, UK: Edward Elgar, 2009), 45-76; Karrberg.

[69] Chloe Albanesius, "Major Mobile Operators Team on Open App Platform," *PCMag*, Feb. 15, 2010, accessed Oct. 31, 2012, http://www.pcmag.com/article2/0,2817,2359363,00.asp.

	Europe	North America	Asia	Comments to the situation in Europe
Innovation Potential	↓	↑	↑	No European Silicon Valley
Infrastructure roll-out	→	↑	↑↑	Companies do not invest against declining revenues
Attractiveness for capital, ideas and new jobs	↓	↑↑	↑	Uncertain regulatory framework, lack of venture capital
Vendor landscape	↓	↓	↑↑	No effective industry police in Europe in place
Over-the-top Players	N.A	↑↑	Regional	No European Silicon Valley

Figure 4: The European Telecom Sector vs. North America and Asia: Areas Where Regulation Might Require and Overhaul [70]

If in the past regulators have responded differently to the perceived expectation that content ought to be separated from delivery, the challenges for the future come from addressing the shortcomings of the European telecom sector. Regulators need to support the sector's sustainability, potential for innovation, capacity for infrastructure roll-out, attractiveness for capital, ideas and new jobs, vendor landscape, and competitive Internet-based companies.

Traditionally telecommunications regulation focused on "conduit" regulation and the need to ensure common-carriage access to basic telecommunications services, for which the public utility view of regulation was long justified by the concept that telephone networks were a natural monopoly.[71] Since 1988, however, other organizations have played an important role in shaping the emergent digital infrastructures. The FCC, the Commission of the EU, and OFCOM are examples of regulators that exercise significant powers in establishing directions for business, as well as providing protection to consumers.

Currently, regulation consists of mediating among telecom operators, platform owners, consumers, and other actors in the provision of digital services. As the demands for bandwidth increased and sharing was for a while a way for regulators to try to enable fast action to solve some of the major

[70] International Telecommunications Union, "General Conclusions and Executive Summary of the Final Report," 2.
[71] Clark, Lehr, and Bauer; Tim Wu, *The Master Switch: The Rise and Fall of Information Empires* (New York: Alfred A. Knopf, 2010).

requirements for demand, a number of issues on network neutrality and competition emerged.[72] Examples of these are the FCC commitment to network neutrality[73] and the Digital Agenda for Europe 2020,[74] which is trying to affect an upgrade of the current copper networks to fiber in order to enhance fast digital connection for EU citizens and businesses.

European operators are facing opposition from the European Commission and local market regulators as they seek to create "joined-up" cross-operator solutions via joint ventures and partnerships. For example, the Euro 5 (composed of five major European operators: Orange, Telecom Italia, Vodafone, Deutsche Telekom, and Telefonica) are working together to launch interoperable services, including near field communications transactions, with standard technical and commercial frameworks in their core markets during 2012. However, they are now being investigated by Europe's top antitrust enforcer on the grounds that they may have excluded competition and acted in a way that is detrimental to third parties and consumers. Moreover, implementing solutions in local markets is also fraught with difficulty as different national regulators interpret European Union anti-trust law differently.[75]

The physical as well as digital links between content delivery and access networks attracts attention from regulators because of the high volumes of data exchanged, and the implications of this high volume for internal costs. The high content-related value of this data raises questions as to whether one or another actor will have sufficient market power to benefit by extracting excessive profits from the value of the content rather than its delivery. Other features of interconnection, including privacy and data sharing concerns, and roaming charges, need to be understood conceptually before effective regulation that is independent of short-term technological changes can be put in place.

CONCLUSIONS AND IMPLICATIONS

In the telecommunications sector, the study of traffic and its relationships with business models should help to develop sense-making of how the emergent agents (e.g. platforms, CDNs, etc.) can conduct effective business with the telecom operators in the provision of digital services. These agents are able to juggle, in a very effective manner, the strategies and requirements for the development of the digital provision of products and services. In this article we have considered the dynamics of control and focus on the different modular types of traffic that provide a unique view on the value propositions of providing the Internet. Through our approach, different arrangements for the fostering of digital innovation and enterprise strategies can be identified. Furthermore, within the European context, our analysis gives insight on what is driving innovation and why, and in the real patterns of value flows generated by new business models.

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[72] Ghassan Hasbani, Bahjat El-Darwiche, Mohamad Mourad, and Louay Abou Chanab, "Telecom Infrastructure Sharing: Regulatory Enablers and Economic Benefits," white paper, Booz Allen Hamilton Inc. (2007).
[73] Federal Communications Commission, "In the Matter of Preserving the Open Internet."
[74] European Commission, 42. See also OFCOM, "UK Fixed-Line Broadband Performance," report, May 2011, 109.
[75] Telco2.0 Research, "Telco 2.0 Solutions for Third-Party Companies Hindered by Confused Operator Strategies," white paper (2012), 29.

The combination of the traffic demand, business models, and regulatory aspects influencing the European telecommunications sector in the analysis can also provide models of possible new pricing structures and economic propositions. By focusing this analysis on type of traffic, we will move away from a "just pipe" approach to the provision of the digital services some telecom operators have adopted. This has required a revision of the traditional view of the telecom sector that focuses on market concentration, barriers to entry, interconnection pricing, availability, and take-up of broadband access.

CDNs are becoming increasingly important as alternative creators of business models and pricing structures of the physical infrastructure as supplier of bandwidth for the digital services they supply. Furthermore, as CDNs strengthen their business operations they will be able to benefit from the missteps of the telecommunications operators. There are multiple issues with the current approaches of telecom operators to the migration of services to new digital infrastructures; this is tangible when carrying out an analysis of business practices. The next task is to define a new discourse for the discussion of the telecommunications agenda beyond regulation as a pivot for sustainability and innovation.

Some years ago it seemed sensible to discuss the possibility of sustaining a business focused exclusively on infrastructure construction, upgrading, and maintenance. The current structure of network utilization and the business models that are emerging make it economically infeasible to continue to promote the idea of a "dumb pipe" industry alongside a services and content industry with the current market structure and regulatory regimes.[76] To do so risks the sustainability and innovative capacity of the network, as we have seen in Europe over the past ten years. Meanwhile, some analysts propose that a high level of network integration will lead to specialization which can then lead to more balanced models for exploiting the telecom brands and pipes.[77] It is still to be seen if telecom operators will be able to compete with the new actors emerging in the provision of products and digital services or if they will merely consider themselves as pipes and hence adopt some more feasible utilities model for their pricing structure. If in the past telecommunications operators could afford to ignore the changing Internet around them, this is no longer the case, and they need to react quickly to the transition to a more competitive digital market for products and services that overcomes their structural, contextual, governance, and managerial or organizational status.

Frischmann contrasts the relatively poor competitive situation in the United States with other countries.[78] US consumers generally have a less competitive market than Europeans, whose telecom

[76] Amazon is an example of how some CDNs have developed an array of services and business models based on creating a "private" Internet using AS-based clouds and using telecom operators simply as bandwidth pipes. Robert McMillan, "Amazon's Secretive Cloud Carries 1 Percent of Internet," *Wired*, Apr. 18, 2012, accessed Oct. 31, 2012, http://www.wired.com/wiredenterprise/2012/04/amazon-cloud/?utm_source=linkedin.
[77] Marcel Van de Pol, Ard-Pieter de Man, Sjoerd Wolthers, and Simone Speet, "Rethinking the Traditional Telco," white paper, ATOS Consulting (2011), 9.
[78] Frischmann.

sector is highly fragmented.[79] Frischmann also points out that regulation and the assumptions of network neutrality can look very different under conditions of diverse levels of engagement and protection, as we see in legislative responses in the Netherlands, Italy, Hungary, and elsewhere.

In this article we have described the key positions of major actors in the telecommunications system. We also demonstrate an analytical approach to policy that emphasizes the public affairs concerns (e.g. regulation and innovation) and an analytical approach to business practices and strategy aimed at demonstrating the strategic quandary of operators using the resultant business models.

[79] San Francisco, a city very close to the Silicon Valley, counts only one known major telecom supplier. Compare this with the United Kingdom, where London has up to five mobile providers and three major telecom suppliers.

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